

COMPUTERDIGEST

VOL. 4 NO. 1

JAN. 1987

A NEW KIND OF MAGAZINE FOR ELECTRONICS PROFESSIONALS

TVRO

You Can Use Your Computer To Aim The Dish



5 VOLT RS233

Something Else You Can't Live Without!

ALL ABOUT INTERFACING PART II

Completing And Testing Your
Interconnections

A
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PUBLICATION

CONTENTS

Vol. 4 No. 1

January 1987

6 TVRO Antenna Pointer

Finally, a quick and easy system that can be used to advantage whether you erect lots of dishes each week, or just one for yourself.
Edmund T. Tyson

10 5-Volt RS-232

There's a new chip available that's making a lot of circuitry a thing of the past. It's called the MAX232 and here's how to use it.
Rodney A. Kreuter

12 TV Channel Frequency Program

Enter this program, do it just once, and you'll never have to look those numbers up again. **Michale Kiley, WA9ZPM**

13 All about Interfacing, Part II

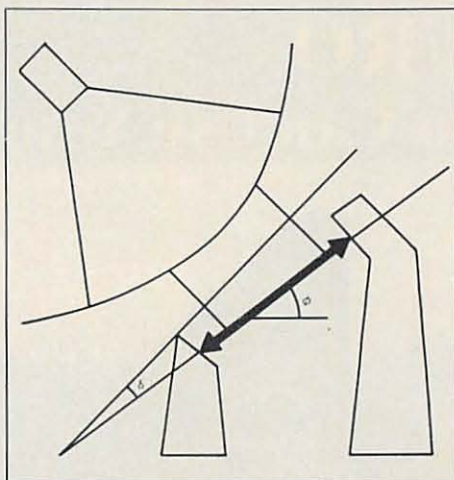
We began this article last month and present the conclusion here. This one is a "Clip-and-Save!" **Jeffrey K. Holtzman**

3 Editorial

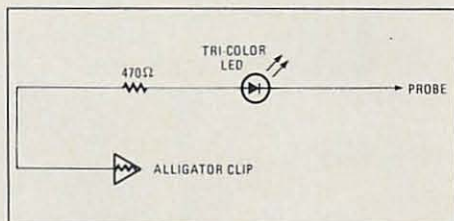
4 Letters

4 Computer Products

5 Software Review



See Page 6



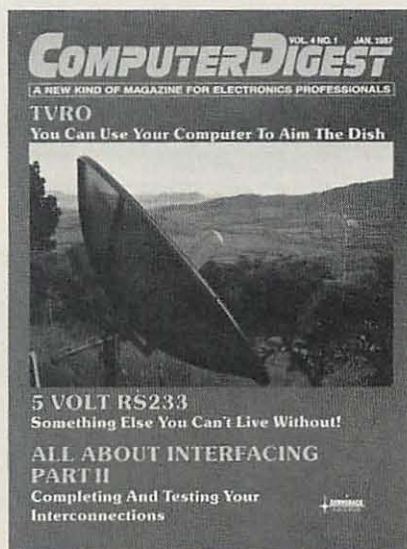
See Page 13

ON THE COVER

Author Ed Tyson has been busy putting in TVRO installations. The one on this month's front cover is from the McDonald Observatory, in Texas. The complete article begins on page 6 of this issue. In error, the article was run last year in the October Issue, with the wrong program.

COMING NEXT MONTH

Every once in awhile, an editor can sit back and smile with some small measure of pride over a well-done job. And before I break my own arm patting myself on the back, here's what's in store for you: A build-it-yourself protocol converter, a TV channel frequency program, a story on undocumented op codes that just might make your next chip a lot more useful, and an up-to-the-minute article on concurrency that you *have* to read! Don't miss our next great issue!



EDITORIAL

The beginning of the end...

■...Of copy protection is at hand. Ashton-Tate, who manufacture such important software programs as dBase database managers, recently announced that copy protection would be removed from all its software. We applaud Ashton-Tate for this action.

Manufacturers assumed that the computer operator was going to make copies of any software he purchased, distributing it to all his friends or (worse yet) selling unlimited copies for less than he paid for it. Naturally, this sort of piracy would cost the software manufacturer, for it would reduce the potential for sales.

So copy protection would be installed on the software. This made it extremely difficult for a legitimate user to make a backup copy, or to store on his hard disk. As for the real pirate, it didn't stop him, it was just another nuisance he had to work around. And the truth of the matter is that copy protection didn't do any more than create problems without solving any.

Today, we see advertisements that read "Not copy protected." And we're starting to see more and more of those advertisements as well.

Certainly, the manufacturers are entitled to a profit from their investment in a software program, but we already have such protection in place in the form of our copyright laws. These can cover a new software just as easily as they would cover a new book that's been published. And copy protection is to software, what locking closed the pages of a book would be. While this writer is certainly not a lawyer, it seems that the plagiarism and copyright laws that are now in place, should be sufficient protection if the need to exercise them ever arises.

Ashton-Tate, long a leader in our industry, has taken a major forward step. We can only hope that others will follow. ◀▶

Byron G. Wels

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editor-in-chief, emeritus

Larry Steckler,
EHF, CET: publisher & editor in chief

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Byron G. Wels,
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Andre Duzant,
technical illustrator

Jacqueline P. Cheeseboro
circulation director

Arline R. Fishman,
advertising director

Computer Digest
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Executive offices

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President: Larry Steckler

Vice President: Cathy Steckler

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Larry Steckler
Publisher

NATIONAL SALES

Joe Shere

1507 Bonnie Doone Terrace
Corona Del Mar, CA 92625

714-760-8967

LETTERS

Flight Simulators

I've been playing around with flight simulators on my computer. Can those things actually teach me to fly?—R.D., Tacoma, WA.

They can sure save you a lot of expensive dual-time when you're learning navigation, but as an old-timer once said, "If you want to learn about flying, watch the birds. But if you want to learn HOW to fly, get into an airplane!"

Bridge for Sale!

My new computer has been nothing but trouble since I bought it, and the salesman explained that it just takes time to break-in. Exactly how long should this break-in period be?—L.B., Oshkosh, WI.

At least until the 3,000 mile check. Now let me tell you about this slightly-used bridge in

Brooklyn that I can let you have real cheap... But seriously, get to a technician if you're having problems.

Who Goofed?

Somebody goofed up in the October Issue last year. You announced a TVRO Antenna Pointer, and the program talked about anything but that. Wha' happen?—S.T., Kansas City, MO.

Mea culpa, mea culpa, mea maxima culpa. Make sure you check the table of contents for this issue. I'm pretty sure we got it right this time.

To Err Is Human

What happens if a mistake is made in the magazine and I build something and it doesn't work? Am I just "stuck"? R.P., Jericho, NY.
Not at all! Actually, if you had

any idea of the complexity involved in getting an author's "rough" diagrams to the finished, printed page, you'd be surprised that even more mistakes are not made. If you do have a problem, by all means write in and let us help you solve it.

Hi, Brilliant!

I happened on your magazine at my dentist's office and started flipping the pages. To my surprise, I was able to understand much of it, even though I have no real background in electronics, much less computers. I guess I'm just brilliant. Talking to my dentist later, I found that he has a personal computer and well—to make a long story short—my subscription is enclosed. T.P., Long Beach, CA.

Welcome to the 20th Century! Delighted to have you with us.

COMPUTER PRODUCTS

For more details use the free information card inside the back cover

GAME PROGRAMS, *Gerry and the Germ* and *Microcosm*, are the latest titles released in Firebird Licensees' Super Silver Disk series for Commodore 64/128 computers.



CIRCLE 18 ON FREE INFORMATION CARD

Gerry the Germ, is a lighthearted romp through the human body as Gerry sets out to prove his worth as a virulent virus. *Microcosm* puts the player aboard a crippled interstellar freightliner as the sole defender of a priceless agricultural cargo against a devouring horde of mutant insects.

Both games feature musical and sound effects, graphics and animation, challenging play action and either joystick or keyboard control.

The suggested price is under \$20.00—**Firebird**, P.O.Box 49, Ramsey, NJ 07446.

MEMORY UPGRADES, The *XTend Kits* are designed for use with the IBM XT and portable computers. The *XTend* upgrade involves removing the XT's system board, replacing two rows of 64K RAMS with 256K RAMS, removing a decoder PROM, and installing a specially programmed replacement, and inserting a 16-pin IC into an empty socket on the board.

One model of the *XTend* upgrade kit allows the user to upgrade an XT for \$10.00 (not including RAM chips). The *EXTend Multi-Pak*, priced at \$99.00, includes a decoder and logic chips to upgrade ten computers. It includes 10

diskettes and 10 software manuals.

The *XTend Plus* kit, which also sells for \$99.00, provides everything the

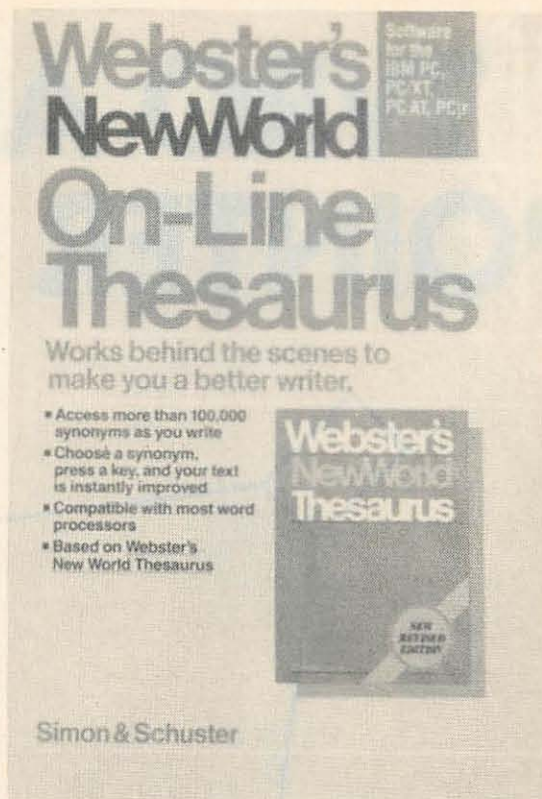


CIRCLE 19 ON FREE INFORMATION CARD

user needs to perform an upgrade on a single XT, including RAM chips. The basic *XTend* kit includes RAMtest, RAMdisk, and Printer Spooler software on diskette, as well as a handy IC puller. Also included are hardware installation and software operation manuals.—**VERICOMP**, 8825 Aero Drive (Suite 210), San Diego, CA 92123.

SOFTWARE REVIEW

Webster's new On-Line Thesaurus...



■ This offering from Simon and Schuster (\$69.95, Simon and Schuster, Rockefeller Center, 1230 Avenue of the Americas, New York, NY 10020) is the latest entry in the writer's-aid market and a good way to supercharge your favorite word processor. It was written by Korenthal Associates of New York, and is based on the Webster's New World Thesaurus and has over 120,000 cross-referenced synonyms to help find exactly the word or phrase you want. There are many thesaurus' on the market, but this one can't be beat on a feature-for-feature basis.

When you run the installation program, you'll see that Webster's already knows about 26 of the popular word processors. If yours is among them, all you've got to do is press a key. If yours is not on the list, you tell Webster's how yours works. All it needs to know is the key you press for insert, delete, etc. If you know your word processor, you can get through the installation in under a minute. And changes can be made as easily, even from inside your word processor.

Webster's is made up of two files. First is the control program in high memory until you reboot. It watches the keyboard buffer, and when it sees the key you've set as the trigger, it puts a window on the screen and hunts the phrase or word at the cursor, in the dictionary, which is the second file. Webster's is smart. If it can't find a match, it will show a list of words spelled like the word you are seeking. If your word is not there, you can browse through the entire dictionary, try alternate spellings, see synonyms for any word on the list, or even synonyms for the synonyms.

It's easy to use. Since it weighs in at 360K, it should really be run off a hard disk. You can use it in a two-drive system, but one will have to be dedicated to the dictionary. If you have sufficient memory, you can stuff it in ramdisk but this might leave you short on space for your word processor. It will work in whatever configuration you create, and whatever limitations exist will be set by your hardware, not Webster's software.

Once you're up-and-running, you only have to remember the key that activates the Thesaurus. The F1 key offers a complete help screen, but after a few times, you won't need that anymore. The program looks up the word at the cursor, you browse through the suggested synonyms using the cursor keys and pressing the F10 key makes the substitution.

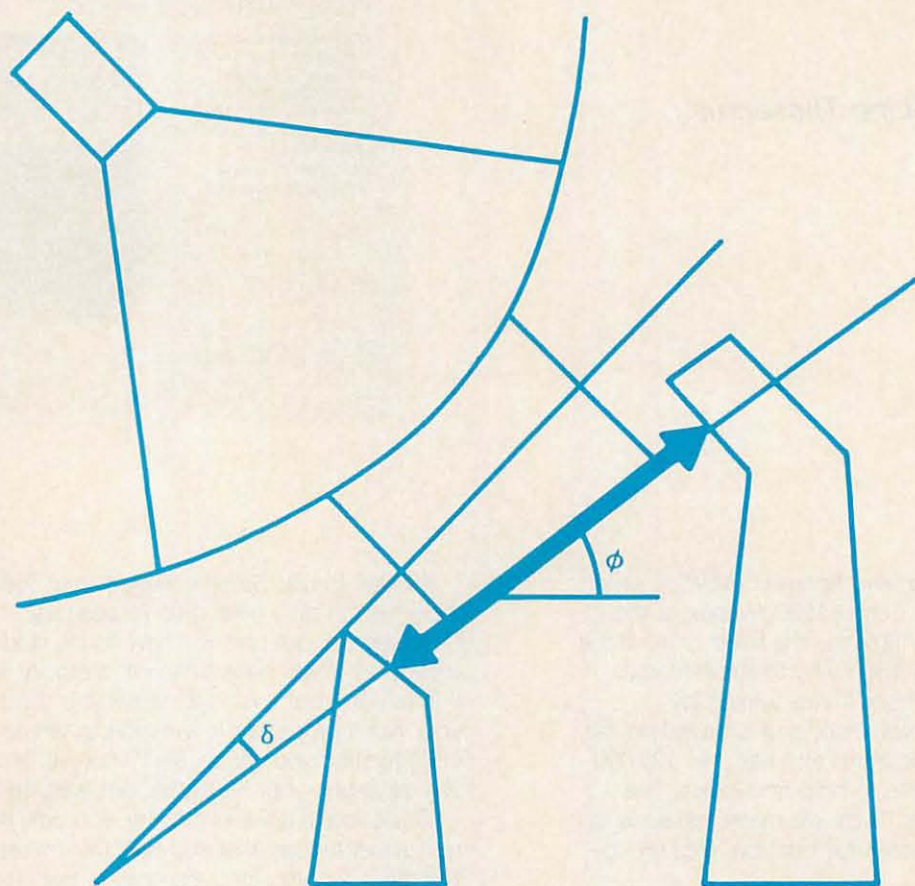
It first looks for the entire word, and if there's no match, it seeks the root of the word. If that fails, it shows you a list of words with similar spellings.

Each control program can contain parameters to make it work with three different word processors and you can switch between them. By installing and saving a second time under a different name, you can put several versions on a single disk. The written manual walks you through it step-by-step. And the manual has some interesting appendices on word usage in general.

Using Webster's is habit forming. Once you're accustomed to it, there's no way you'll use your word processor without it. And when you realize that it does about twice as much as its competitors for less than half the price, you'll realize that it's more than just a bargain—it's an outright steal! ◀▶

CIRCLE 17 ON FREE INFORMATION CARD

TVRO ANTENNA POINTER PROGRAM



Your computer can accurately point your TVRO antenna.

Edmund T. Tyson

■ Most articles give pointing angles in azimuth/elevation coordinates. But the working coordinate system for most antennas is identical with the astronomical hour angle/declination coordinate system. In this system, the hour angle axis is parallel with the spin axis of the Earth and the declination axis is orthogonal to the hour angle axis. So the antenna points to any satellite in the Clarke belt by motion about a single axis. The Clarke belt is a band in space above the equator, some 22,240 miles up. Satellites in this belt make one revolution about the Earth in a day, so they appear fixed in one spot in the sky.

About the program

This program calculates angles for pointing TVRO antennas at synchronous satellites. It is written in BASIC for use on many computers. We tested it in midsummer by computing telescope settings to observe satellites broadcasting TV signals. A telescope observatory in the southwest confirmed the angles by seeking and finding the satellites. A dial was designed that permits pointing an antenna at a chosen satellite without searching.

The program is useful only for calculating synchronous satellite positions and is based on these assumptions: Inclination of the satellite orbit to the

```

100 COMPUTE POINTING ANGLES
105 FOR TVRO ANTENNA
110
120 DEF SNG A-H, 0-Z
130 DEFINT I-N
140 CLS
150 PI=3.141593#
160 D2R=PI/180!
170 RE=6378.165
180
200 ***** OBSERVER COORD *****
210 PRINT "OBSERVER N LAT/W LONG"
215 INPUT ,FLAT, FLONG
220 FLONG=-FLONG
221 WLONG=-FLONG
225 LPRINT "TVRO AT N LAT="
226 LPRINT ,FLAT, " W LONG=", WLONG
227 LPRINT
230 X=I!
240 Y=O!
250 Z=O!
260 ROTATE ABOUT "Y" BY LAT
270 AX=FLAT
280 IAX=2
290 GOSUB 1000
300 ROTATE ABOUT "Z" BY -LONG
310 AX=FLONG
320 IAX=3
330 GOSUB 1000
340 XO=-X
350 YO=-Y
360 ZO=-Z
390 LPRINT "SAT LONG AZIM",
391 LPRINT "ELEV HR AX",
392 LPRINT "DEC AX RANGE KM"
399 *****
400 ***** SAT COORD *****
410 CLS
415 LPRINT
420 INPUT "SAT LONG", SLONG
421 SLAT=O!
425 SLONG=-SLONG
426 GLO=-SLONG
428 RADIUS VECTOR OF
429 SYNC SAT = 6.611 ERU
430 X=6.611
431 Y=O!
432 Z=O!
435 ROTATE RV ABOUT "Y" BY SLAT
436 AX=SLAT
437 IAX=2
438 GOSUB 1000
440 ROTATE RV ABOUT "Z" BY -SLONG
441 AX=SLONG
442 IAX=3
443 GOSUB 1000
450 TRANSLATE EQ COORD
451 TO OBSERVER
455 XS=X+XO
456 YS=Y+YO
457 ZS=Z+ZO
460 COMPUTE HOUR ANGLE
461 AND DECLINATION
470 GOSUB 2000
471 DAH=(AX/D2R)+FLONG
472 REQ=SQR(XS*XS+YS*YS)
473 DAD=ATN(ZS/REQ)/D2R
474 RS=SQR(REQ*REQ+ZS*ZS)*RE
500 ***** ROTATE TO TOPOS *****
501
510 X=XS
511 Y=YS
512 Z=ZS
515 ROTATE TRANS COORD
516 ABOUT "Z" BY (LONG-90)
520 AX=-FLONG-90!
521 IAX=3
522 GOSUB 1000
530 ROTATE TRANS COORD
531 ABOUT "X" BY (LAT-90)
535 AX=FLAT-90!
536 IAX=1
537 GOSUB 1000
540 XS=-Y
541 YS=X
542 ZS=Z
543 RT=SQR(XS*XS+YS*YS)
545 GOSUB 2000
550 AZ=AX/D2R
551 EL=ATN(ZS/RT)/D2R
LPRINT USING"*****",GLO;
LPRINT USING"*****",AZ;
LPRINT USING"*****",EL;
LPRINT USING"*****",DAH;
LPRINT USING"*****",DAD;
LPRINT USING"*****",RS
580 GOTO 400
999 *****
1000 COORD ROTATION ROUTINES
1010
1020 AXR=AX*D2R
1030 SINX=SIN(AXR)
1040 COSX=COS(AXR)
1050 XT=X
1060 YT=Y
1070 ZT=Z
1080 ON IAX GOSUB 1100,1200,1300
1090 RETURN
1100 *****X ROT*****
1110 X=XT
1120 Y=YT*COSX+ZT*SINX
1130 Z=-YT*SINX+ZT*COSX
1140 RETURN
1200 *****Y ROT*****
1210 X=XT*COSX-ZT*SINX
1220 Y=YT
1230 Z=XT*SINX+ZT*COSX
1240 RETURN
1300 *****Z ROT*****
1310 X=XT*COSX+YT*SINX
1320 Y=-XT*SINX+YT*COSX
1330 Z=ZT
1340 RETURN
2000
2005 QATAN
2010 ARC TAN IN PROPER QUADRANT
2020 IF XS<0 GOTO 2060
2030 IF YS=0 THEN AX=0: RETURN
2040 IF YS<0 THEN AX=PI/2: RETURN
2050 IF YS>0 THEN AX=1.5*PI: RETURN
2060 AX=ATN(YS/XS)
2070 IF XS<0 THEN AX=AX+PI: RETURN
2080 IF YS<0 THEN AX=2*PI+AX
2090 RETURN

```

equator is small, eccentricity of the orbit is small, and the semi-major axis of the orbit is 6.611 Earth radii.

You need north latitude and west longitude of the antenna and west longitude of the satellite. South latitude and east longitude values must be entered as negatives. The program can be used for any geographical location of the observer and satellite longitude. Negative elevation angles show the satellite below the horizon for that location.

When executed, the program prompts for the geodetic position of the antenna and this is printed to label that data. Antenna position is then converted to geocentric rectangular coordinates and saved. Additional prompts request west longitude of each new satellite. These positions are converted to geocentric rectangular coordinates, antenna coordinates are subtracted and the vector is solved for hour angle and declination.

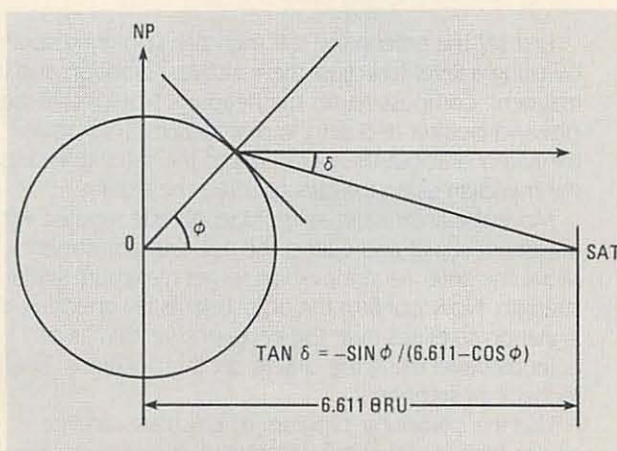


FIG. 1—DECLINATION OR OFFSET ANGLE is shown above. This is a sketch of Earth and satellite seen from the equatorial plane. The relation is described by the equation.

The hour angle

Hour angle is measured about the polar axis of the antenna mount. It's zero when the satellite is on the meridian, negative when the satellite is east of the observer, positive when it is west. Declination is the angle created by the observer's displacement from the equator. It is included in the mount setting by the *offset*

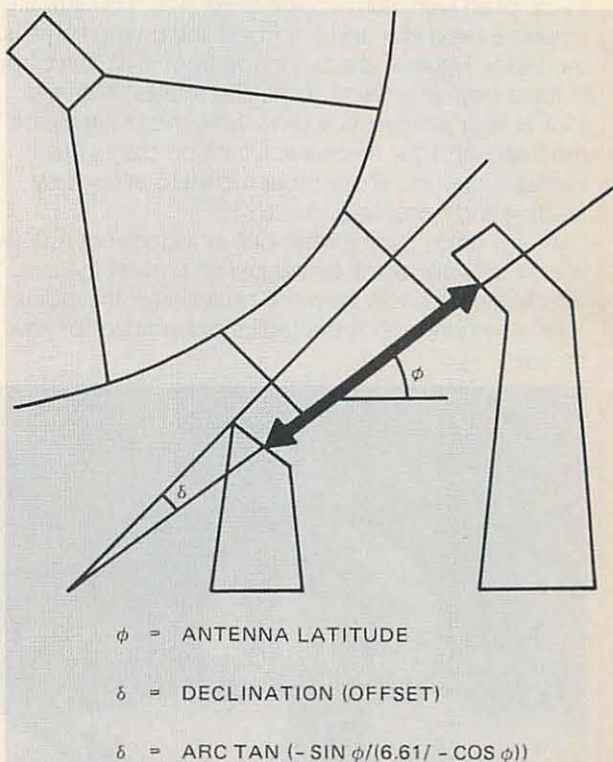


FIG. 2—HOW LATITUDE and declination angles are included in the antenna mount. The difference vector is rotated to the observer's position and solved for azimuth, elevation and slant range.

adjustment made during mount and dish assembly. Figure 1 shows the declination or offset angle. This is a sketch of Earth and satellite seen from the equatorial plane. Distance from satellite to Earth's center is 6.611 Earth radius units. An increase in latitude causes a related increase in declination. The equation describes the relation. Once calculated, a fixed angle for declination can be used as the change in declination from a meridian to an extreme east or west position is small compared to antenna beamwidth at C-band. Figure 2 shows how latitude and declination angles are included in the antenna mount.

The difference vector is then rotated to the observer's position and solved for azimuth, elevation and slant range. Azimuth is in degrees from north around through east as in the graduations of a compass. Elevation is in degrees above the horizon with zero degrees at the horizon and 90 degrees directly overhead. Slant range is the distance from antenna to satellite.

The printed output lists observer's position, satellite longitude, azimuth, elevation, hour angle, declination angle, and slant range in kilometers. Almost all TVRO antenna mounts use the hour angle/declination mode of motion. This is the best mount since it lets the antenna be aimed at any satellite by moving it on a single axis. This also allows constructing a simple dial that lets you point at any interesting satellite.

The dial

Figures 3 and 4 are typical dials. Figure 3 is a dial made of an aluminum cookie sheet. The mount rotates around a fixed dial and a scribed line on the frame is the index. Figure 4 is a dial made from .040 sheet stock. A fixed pointer is used as the dial rotates. A careful look at your antenna will show how the dial must be mounted, and the mechanical limit on dial radius. Radius should be at least four inches to allow easy reading and construction.

Aluminum is used for the dial as it does not rust and is easy to work. Use a center punch to mark the axis which can be offset from the center. Mark the radius with a compass using the radius determined for your mount.



FIG. 3—AN ALUMINUM COOKIE SHEET is used as a dial. The antenna mount rotates about a fixed dial with a scribed line on the frame as an index.

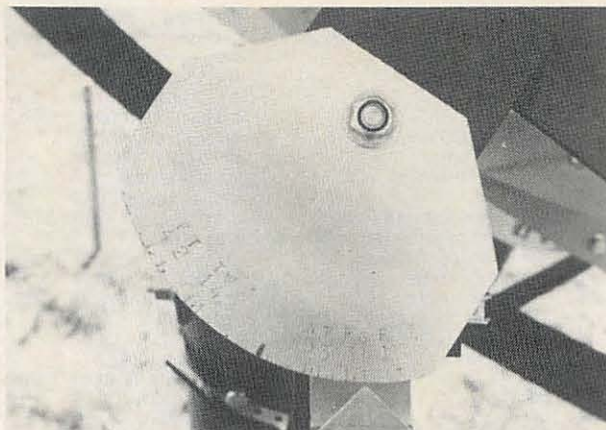


FIG. 4—DIAL FORMED FROM ALUMINUM STOCK. A fixed pointer is used since the dial rotates. Look at your own antenna to select the best form.

With a straightedge, divide the arc in halves to represent meridian or zero point and scribe a line through the punch mark and arc. A protractor is used to mark five degree angular increments of satellite positions as calculated by the computer program. Make sure you make the marks on the correct half of the dial. Satellites to the east of the antenna are prefixed with a negative (—) sign. The correct half changes depending on whether the dial rotates or is stationary.

Angular divisions of five degrees are adequate and can be marked by a double punch mark. Individual satellites are identified by scribing a mark at calculated angles along with an alpha-numeric label such as F4, W4, G1, etc. Antennas separated by a few miles need different dials as a one-degree shift in longitude results in at least a one-degree change on the dial.

A dial is a useful tool for technicians installing many antennas. The time to align can be reduced and precision improved. A dial calculated for the area where installations are done and marked with the east, west and meridian satellites will speed the process of alignment with the Clarke belt and setting remote positioning actuators and indicator systems.

Dial alignment procedure

First set the antenna to the meridian (pointing south) by using a level to adjust the east/west position and a magnetic compass to set the heading. Now install the dial and pointer and set the dial to zero. Then rotate the antenna about the polar axis to the satellite nearest the meridian using the dial to make the setting.

Move the antenna in azimuth to get the satellite with maximum signal and clamp the azimuth adjustment. Move the antenna in elevation to get maximum signal strength. Now confirm the adjustments by checking the signal on satellites near the east and west limits of antenna travel using the dial to set the positions. Finally, recheck all settings.

Use the computer program to calculate satellite angles for a dial for your antenna. A dial is an essential accessory for manually positioned antennas. It will eliminate guesswork when changing from one satellite to another. ◀▶

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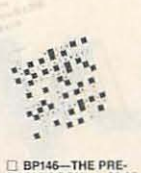
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5-VOLT ONLY: INTRODUCING THE NEW MAX 232

Something new on the horizon...

Rodney A. Kreuter

■I've wound my last DC-DC transformer, built my last 555 voltage doubler/inverter. Thanks to a new chip, the MAX232, from Maxim Integrated Products, all that's a thing of the past.

Ever since the 2716 replaced the 2708 EPROM, bipolar power supplies have been very rare in the digital world - except when an RS-232 interface was required. Every IC manufacturer has strived to make UARTS, RAM, EPROMS, and CPUs five volt only parts. However, since RS-232 is an EIA standard, nothing could be done to change its requirements for bipolar signals.

RS-232 defines a "1" as a voltage between -3 and -27 volts. A "0" is defined as a voltage between 3 and 27 volts. Notice that a voltage between -3 and 3 volts has no meaning in RS-232. It is not a "1" or a "0." For this reason it is called the "dead band."

Some manufacturers cheat RS-232 because of two popular chips that have been used for years to make up an RS-232 interface—the 1488 and 1489. Many manufacturers produce these chips with a different prefix. For example Motorola calls them the MC1488L and MC1489L.

The 1488 is the line driver. When powered by +12 and -12 volts, it converts a TTL signal to a proper RS-232 level. As a matter of fact, it will just barely meet the RS-232 standard levels when powered by +5 and -5 volts, although no specifications are given by Motorola for any operation below +6 and -6 volts. Noise immunity suffers from powering the chip with less than ± 12 volts as does the maximum distance the signal can travel, so most people stick to ± 12 volts. The 1489 line receiver is where the idea to cheat RS-232 begins. The 1489 has an adjustable 'threshold'.

This threshold is the voltage at which a "1"/"0" decision is made. It can be set to any voltage between -3 and +3 volts. The default setting (which 75% of the manufacturers use) is about 1 volt. This means that anything below a volt will be read as a "1" and anything above a volt as a "0" (note the negative logic). Since normal TTL signals swing from 0.8 to 2.4 volts, why bother to use the 1488 at all? Because some manufacturers do use the threshold adjust and set it to -3 or +3 volts! Anyway 0.8 volts is just barely below 1 volt and operation can be marginal.

To sum it up simply, before the MAX232, in order to be sure of meeting the RS-232 standard you needed a bipolar power supply to obtain the negative voltage to power the 1488.

The MAX232 changes all that by providing a proper RS-232 level from only +5 volts. It contains a +5 to +10 volt voltage doubler, a +10 to -10 volt inverter, two line drivers (TTL to RS-232 converters), and two line receivers (RS-232 to TTL converters). In its basic configuration it requires four low-cost capacitors as shown in figure 1. Adding a second chip to increase the number of RS-232 lines requires two MAX232 chips and six capacitors as shown in figure 2.

The value and type of capacitors used will depend on your application and can best be explained by the Maxim Integrated Products data sheet:

"The MAX232 power supply section contains two charge pumps. The first uses external capacitor C1 to double the +5V input to +10V, with an output impedance of approximately 200 ohms. The second charge pump uses external capacitor C2 to invert the +10V to -10V, with an overall output impedance of 450 ohms (including the effects of the +5 to +10

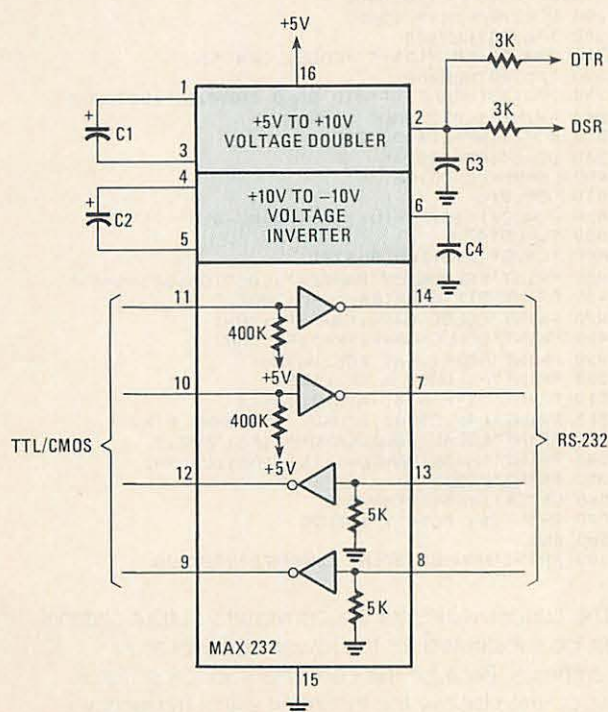


Fig. 1—FOUR LOW-COST CAPACITORS are needed in the basic configuration shown above.

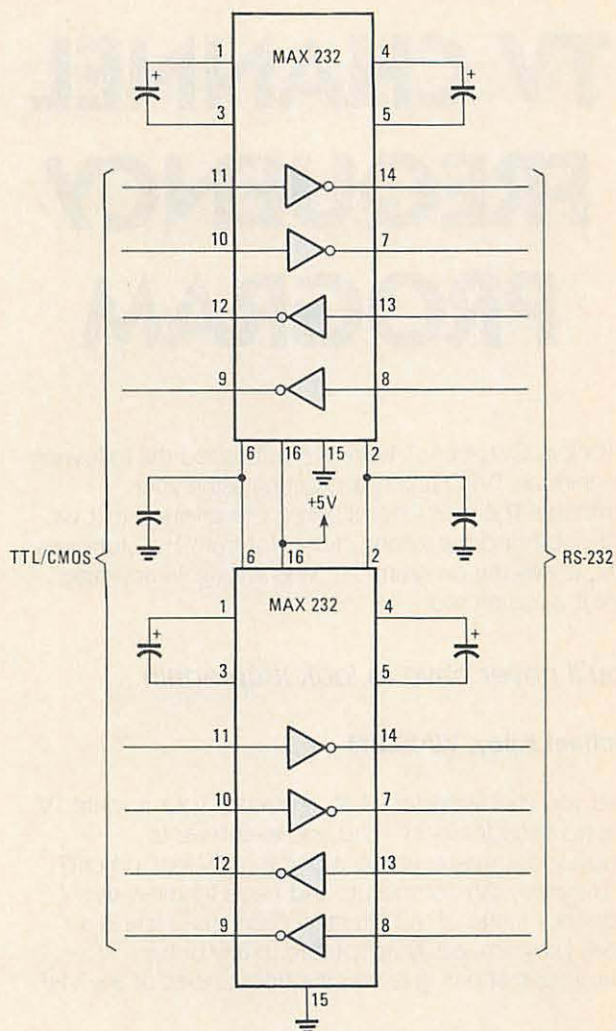


Fig. 2—ADDING A SECOND CHIP to increase the number of RS-232 lines requires two MAX232 chips and six capacitors.

voltage doubler impedance).

The test circuit uses 22 μ F capacitors for C1-C4, but the value is not critical. Normally these capacitors are low cost aluminum electrolytic capacitors, or tantalum if size is critical.

Increasing the value of C1 and C2 to 47 μ F will lower the output impedance of the +5V to +10V doubler by about 5 ohms and the +10V to -10V inverter by about 10 ohms. Increasing the value of C3 and C4 lowers the ripple on the +/- 10V power supplies, thereby lowering the 16kHz ripple on the RS-232 outputs. The value of C1-C4 can be lowered to 1 μ F in systems where size is critical, at the expense of an additional 20 ohms impedance in the +10V output, 40 ohms additional impedance at the -10V output, and 250mv of 16kHz ripple on V-."

The MAX232 can be purchased directly from the factory at: Maxim Integrated Products, 510 N. Pastoria Ave., Sunnyvale, Ca. 94086, (408)737-7600. It can also be obtained through these nationwide distributors: Bell Industries, Diplomat, Hallmark.

Price quotes for the commercial package as of January 6th, 1986 are: 1 - 24 pieces, \$5.40 each; 25 - 99 pieces, \$4.32 each; 100 + pieces, \$3.60 each. ◀▶

TV CHANNEL FREQUENCY PROGRAM

Back in October of 1986, we published the following program on TVRO antenna pointing using your computer. The mail that followed complained that we had published the wrong story. Not true! The story was right, it was the program that was wrong. In any case, here it is, corrected.

You'll never have to look it up again...

Michael Kiley, WA9ZPM

■Did you ever wonder what frequency your favorite TV channel broadcasts on? Did you ever have to troubleshoot master antenna or cable TV equipment? Or diagnose TVI complaints and need to know the frequency range of the affected channels? Here is a BASIC program, easily adaptable to any home computer, that will give you the frequencies of any VHF

```
TV CHANNEL FREQUENCY DIRECTORY
*****
ENTER TV CHANNEL: 2
FREQUENCY RANGE= 54 TO 60 MHZ.
PIX CARRIER= 55.25 MHZ.
COLOR CARRIER= 58.83 MHZ.
SOUND CARRIER= 59.75 MHZ.
NOTE: THE FOLLOWING
ASSUMES A RECEIVER
WITH A 41-47MHZ I.F.
(41.25MHZ SOUND, 45.75MHZ PIX.)
LOCAL OSCILLATOR= 101 MHZ.
IMAGE RANGE= 142 TO 148 MHZ.
MORE?Y
*****
ENTER TV CHANNEL: 7
FREQUENCY RANGE= 174 TO 180 MHZ.
PIX CARRIER= 175.25 MHZ.
COLOR CARRIER= 178.83 MHZ.
SOUND CARRIER= 179.75 MHZ.
NOTE: THE FOLLOWING
ASSUMES A RECEIVER
WITH A 41-47MHZ I.F.
(41.25MHZ SOUND, 45.75MHZ PIX.)
LOCAL OSCILLATOR= 221 MHZ.
IMAGE RANGE= 262 TO 268 MHZ.
MORE?Y
*****
ENTER TV CHANNEL: 13
FREQUENCY RANGE= 210 TO 216 MHZ.
PIX CARRIER= 211.25 MHZ.
COLOR CARRIER= 214.83 MHZ.
SOUND CARRIER= 215.75 MHZ.
NOTE: THE FOLLOWING
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(41.25MHZ SOUND, 45.75MHZ PIX.)
LOCAL OSCILLATOR= 257 MHZ.
IMAGE RANGE= 298 TO 304 MHZ.
MORE?Y
```

or UHF TV channel, as well as cable channels 14 through 36 or A through W. After entering and loading the program and RUNNING it, simply type the desired TV channel number or letter, followed by a <return>. When entering channels above 13, the prompt "UHF OR CABLE?" will appear. Type U or UHF for UHF, or C or CABLE for a cable channel, followed by a <return>. Immediately, a list of the channel band limits, picture, color and sound carrier limits will appear. Assuming the receiver or converter has a standard 41-47MHz IF, the local oscillator and image response frequencies will be given. Virtually all TV sets made after 1960 use this IF but some top-of-set UHF and cable converters heterodyne the incoming frequency directly to the output channel, which becomes its IF. In such cases, make the following changes:

430 FL=ABS(LB-(output channel lower range limit))

440 IL=ABS(LB-(output channel lower range

limit)*2):IU=ABS(UB-(output channel upper range limit)*2)

500 PRINT "IS FOR A CONVERTER"

510 PRINT "WITH AN OUTPUT ON CHANNEL (number of output channel)" Delete line 515.

```
10 PRINT"TV CHANNEL FREQUENCY DIRECTORY"
20 PRINT"*****"
30 PRINT"ENTER TV CHANNEL: ";
35 INPUTA$
40 A=ASC(A$):IFA>64THEN300
50 C=VAL(A$)
100 IFC<2THEN600
110 IFC<5THEN200
120 IFC<7THEN190
130 IFC<14THEN180
140 PRINT"UHF OR CABLE";
145 INPUTB$
150 IF LEFT$(B$,1)="C"THEN320
160 IFC<83THEN600
170 BC=14:BF=470:GOTO400
180 BC=7:BF=174:GOTO400
190 BC=5:BF=76:GOTO400
200 BC=2:BF=54:GOTO400
300 IFA>90THEN600
310 C=A-51:PRINTA$;"=CABLE CH# ";C
320 IFC<40THEN600
330 IFC<23THENPRINT"Mid BAND CHANNEL":GOTO360
340 PRINT"Super BAND CHANNEL"
350 BC=23:BF=216:GOTO400
360 BC=14:BF=120
400 LB=BF+(C-BC)*6
410 UB=LB+6
420 FU=LB+1.25:FC=FU+3.58:FA=FU+4.5
430 FL=LB+47
440 IL=UB+41*2:IU=LB+47*2
450 PRINT"FREQUENCY RANGE=";LB;"TO";UB;"MHZ."
460 PRINT"PIX CARRIER=";FU;"MHZ."
470 PRINT"COLOR CARRIER=";FC;"MHZ."
480 PRINT"SOUND CARRIER=";FA;"MHZ."
490 PRINT"NOTE: THE FOLLOWING"
500 PRINT"ASSUMES A RECEIVER"
510 PRINT"WITH A 41-47MHZ I.F."
515 PRINT"(41.25MHZ SOUND, 45.75MHZ PIX.)"
520 PRINT"LOCAL OSCILLATOR=";FL;"MHZ."
540 PRINT"IMAGE RANGE=";IL;"TO";IU;"MHZ."
550 PRINT"MORE?";
560 GETC$:IFC$="Y"THEN560
570 PRINTC$:IFC$="Y"THEN20
580 END
600 PRINT"NON-EXISTENT CHANNEL":GOTO20
```

The correct values for the converter's output channel must be substituted for the lower-case words in parentheses. Because the converter's local oscillator must operate below the incoming signal frequency instead of above it, as in a TV, the equations are somewhat different. ◀▶

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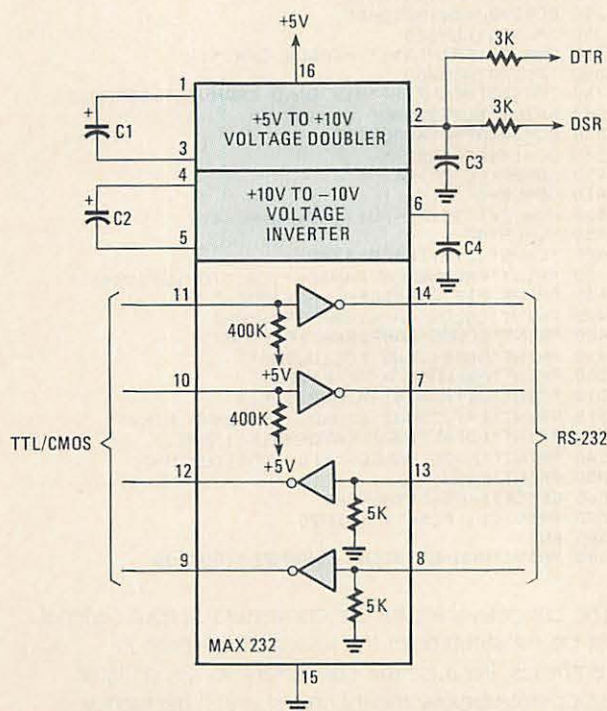


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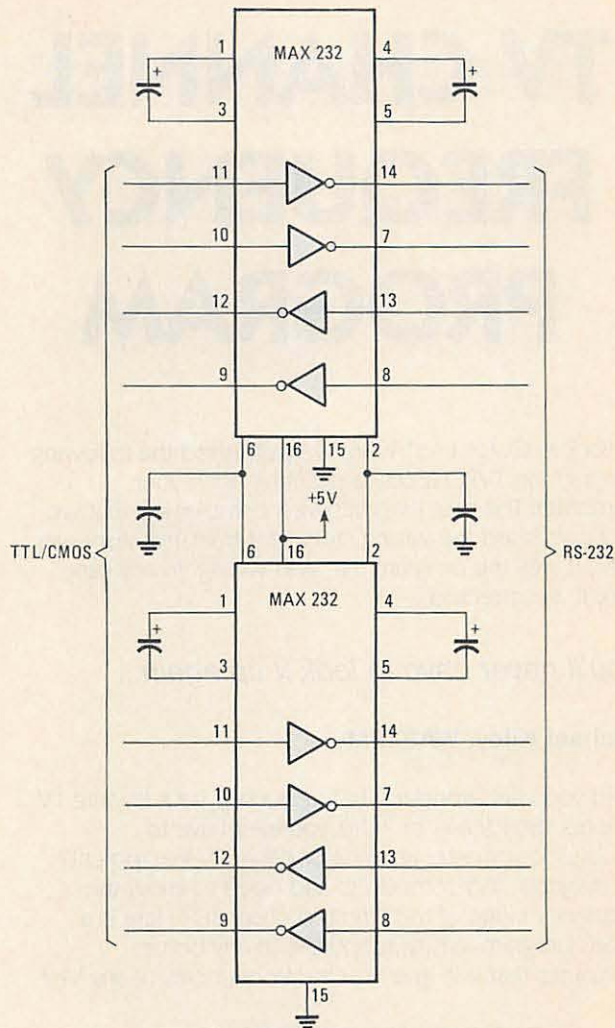


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LOCAL OSCILLATOR= 101 MHZ.
IMAGE RANGE= 142 TO 148 MHZ.
MORE?Y
*****
ENTER TV CHANNEL: 7
FREQUENCY RANGE= 174 TO 180 MHZ.
PIX CARRIER= 175.25 MHZ.
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FREQUENCY RANGE= 210 TO 216 MHZ.
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LOCAL OSCILLATOR= 257 MHZ.
IMAGE RANGE= 298 TO 304 MHZ.
MORE?Y

```

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20 PRINT"*****"
30 PRINT"ENTER TV CHANNEL: ";
35 INPUTA$
40 A=ASC(A$):IFA>64THEN300
50 C=VAL(A$)
100 IFC<2THEN600
110 IFC<5THEN200
120 IFC<7THEN190
130 IFC<14THEN180
140 PRINT"UHF OR CABLE";
145 INPUTB$
150 IF LEFT$(B$,1)="C"THEN320
160 IFC<83THEN600
170 BC=14:BF=470:GOTO400
180 BC=7:BF=174:GOTO400
190 BC=5:BF=76:GOTO400
200 BC=2:BF=54:GOTO400
300 IFA>90THEN600
310 C=A-51:PRINTA$;"=CABLE CH# ";C
320 IFC<40THEN600
330 IFC<23THENPRINT"MID BAND CHANNEL":GOTO360
340 PRINT"SUPER BAND CHANNEL"
350 BC=23:BF=216:GOTO400
360 BC=14:BF=120
400 LB=BF+(C-BC)*6
410 UB=LB+6
420 FV=LB+1.25:FC=FV+3.58:FA=FV+4.5
430 FL=LB+47
440 IL=UB+41*2:IU=LB+47*2
450 PRINT"FREQUENCY RANGE=";LB;"TO";UB;"MHZ."
460 PRINT"PIX CARRIER=";FV;"MHZ."
470 PRINT"COLOR CARRIER=";FC;"MHZ."
480 PRINT"SOUND CARRIER=";FA;"MHZ."
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510 PRINT"WITH A 41-47MHZ I.F."
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520 PRINT"LOCAL OSCILLATOR=";FL;"MHZ."
540 PRINT"IMAGE RANGE=";IL;"TO";IU;"MHZ."
550 PRINT"MORE?";
560 GETC$:IFC$="Y"THEN50
570 PRINTC$:IFC$="Y"THEN20
580 END
600 PRINT"NON-EXISTENT CHANNEL":GOTO20

```

The correct values for the converter's output channel must be substituted for the lower-case words in parentheses. Because the converter's local oscillator must operate below the incoming signal frequency instead of above it, as in a TV, the equations are somewhat different. ◀▶

ALL ABOUT INTERFACING

PART II

JEFF HOLTZMAN

This article, begun last month, is concluded here.

RS-232

In 1969 the EIA (Electronics Industries Association) revised the standards defining timing sequences, voltage levels, and pin designations for serial data transmission. That standard is known as RS-232-C. We will refer to it here as RS-232. The specifications are complex, and many companies alter them—seemingly at random—to suit their own needs, without paying attention to the details. We will discuss some of the uses of RS-232 with microcomputers and common peripherals, rather than the technical specifications.

RS-232 signals are bi-polar; that is, a logical "low" is a voltage below ground, and a "high" is a voltage above ground. These voltages must be equal in magnitude and opposite in polarity. They may range from ± 3 to ± 25 volts, and ± 12 volts is very commonly used in microcomputers. The inactive state of an RS-232 line is low. A low signal is called a space, and a high signal, a mark.

You can implement an RS-232 interface with only 2 wires: a signal and a ground, but the sending software might need to provide delays after characters that cause operations like returning the carriage to the left side of the page, feeding the paper up a line, or feeding a whole page through the printer. Such schemes are used when the timing sequences are well defined, but most consumer equipment makes use of one or more of the hardware or software transmission regulation schemes discussed last time.

Many RS-232 interfaces include other signals with names like CARRIER DETECT, DATA TERMINAL READY, etc. (See Fig. 7.) Many of these signals were developed for use with MODEMs, and were meant to indicate presence on the telephone line of the ringing voltage, special timing signals, secondary transmit and receive lines used for diagnostic functions, etc. Many manufacturers didn't follow the "standards," and started putting all kinds of things on the connector, including power for peripheral devices. For interface devices like printers,

most of those signals aren't used, though some may have to be accounted for.

The "Busy" line is commonly (but not always) available at pin 20 of a 25 pin "D" connector, which is the DTR line. DTR is an acronym for "Data Terminal Ready," and on some machines that signal indicates that the machine has been powered up, whether it is able to receive data or not. The Busy signal also may come on pins 4, 6, 8, 11 or 19. That is usually documented—but not always, and you may have to experiment to find out which is the busy line. The only things you can be certain of are that pin 7 is circuit ground, pin 1 is

Figure 7 RS-232-C DTE Pin Designations		
Pin	Acronym	Description
1	PG	Protective Ground
2	TD	Transmitted Data
3	RD	Received Data
4	RTS	Request To Send
5	CTS	Clear To Send
6	DSR	Data Set Ready
7	GND	Ground
8	RLSD	Received Line Signal Detect
9		Test Pin
10		Test Pin
11		Unassigned (sometimes used for Busy line)
12	SCF	Secondary Received Line Signal Detect
13		SCB Secondary Clear To Send
14	SBA	Secondary Transmitted Data
15	DB	Transmitter Timing
16	SBB	Secondary Received Data
17	DD	Receiver Timing
18		Unassigned
19	SCA	Secondary Request To Send
20	DTR	Data Terminal Ready
21	CG	Signal Quality
22	CE	Ring Indicator
23	CH/CI	Data Rate Selector
24	DA	Transmit Timing
25		Unassigned

FIG. 7—EIA DESIGNATIONS for a standard RS-232 port.

frame ground, and pins 2 and 3 will be input and output pins.

Part of the EIA standard are the two acronyms, DTE and DCE. The former stands for Data Terminal Equipment, and the latter for Data Communications Equipment. The technical specifications are complex, but their meaning is that input and output pins are reversed on the two kinds of equipment. Connecting cables could be wired straight across. Computers usually use pin 2 as the data output pin, and pin 3 as the data input pin. MODEMs reverse those pins so pin 2 on one device may be wired directly to pin 2 on the other; likewise with pin 3.

Printers are (usually) connected as DTE devices, so to connect a DTE computer port to a printer may require that pins 2 and 3 be cross connected (2 to 3 and 3 to 2). To use the same computer port at different times with both a printer and a MODEM usually requires some sort of wiring adapter on one device to reverse the transmit and receive data pins.

A cable which cross-connects inputs and outputs is commonly called a "null-MODEM," named because it replaces two MODEMs connected back to back. If we connected each signal line straight across, inputs would go to inputs, and outputs would go to outputs. That wouldn't do, so it was necessary to cross-connect inputs and outputs. To account for all the MODEM

control signals we would have to wire a cable as shown in Fig. 8a or Fig. 8b. Often we can cross the TD or RD lines as shown in Fig. 8c, and ignore the rest. It is often desirable to connect the serial ports of two personal computers together and use a special program to transfer files between them. Such communications programs frequently use software "Busy" protocols and simply ignore "Busy" pins. If so, the 3-wire configuration shown in Fig. 8c would suffice.

Don't get hung up on the terminology. To wire up interface cables for microcomputers and peripherals, think functions, and ignore the EIA's confusing designations. Many microcomputer interfaces can get by using only TD, RD, GND and BUSY lines between the two devices. Determine which is which on each device using the manufacturer's documentation, or with test equipment. Other lines may often simply be tied high or ignored. Unless you have a reason for including the other lines, ignore them until you have a reason not to.

Hints for debugging serial interfaces

Suppose now that you have just bought a brand new printer from the Chopstick Printer Company of Hong Kong, and all it comes with is a diagram of the output connector—maybe not even that. How would you go about hooking it up to your personal computer?

First get all documentation for both pieces of equipment. Use those documents to draw a diagram (like that shown in Fig. 5 last time) with similarly labeled signals laid out opposite each other. Draw in lines connecting the important signals: RD, TD, GND and BUSY, showing pin numbers at both ends. Check everything over—there is nothing more disheartening than frying a brand-new printer—then wire up a cable using a "break-out" box and the appropriate connectors. Connect the two pieces of equipment.

What if you have no documentation, or have hooked things up according to the manufacturers suggestions—and it doesn't work? Build a test instrument like that shown in Fig. 9. Use a "Tri-color" LED, as it will allow you to see highs, lows and streams of data in different colors. Attach a tiny alligator clip to the resistor and a sharp probe to the LED. Connect the clip to pin seven (ground) of the computer, and turn the power on.

Examine pins two and three. One should be an input and one an output. The output will cause the LED to glow, and the color it glows indicates a low. Record which pin caused the LED to glow, and the color it

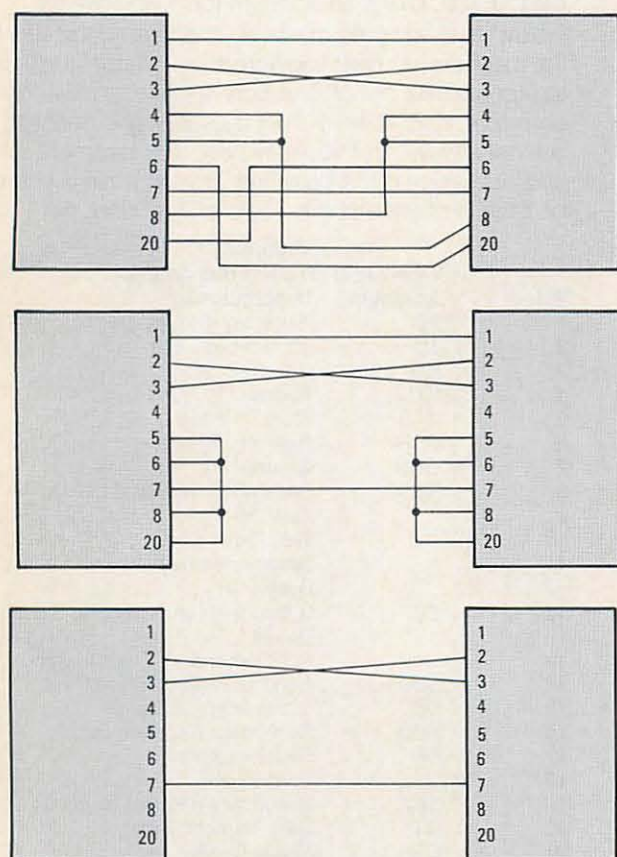


FIG. 8—THREE DIFFERENT NULL-MODEM cables are shown here. Those at a and b use the MODEM control lines, and the one at c is a simple computer-to-computer hook-up. What they have in common is a reversal of the main data lines, pins two and three.

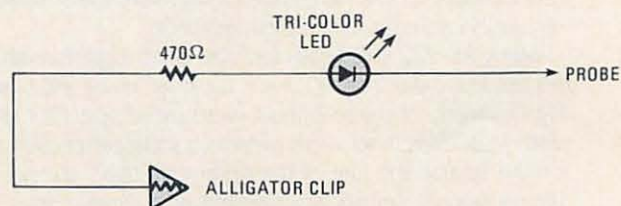


FIG. 9—THIS CIRCUIT comes in handy for debugging both parallel and serial interfaces. Use a tri-color LED for best results.

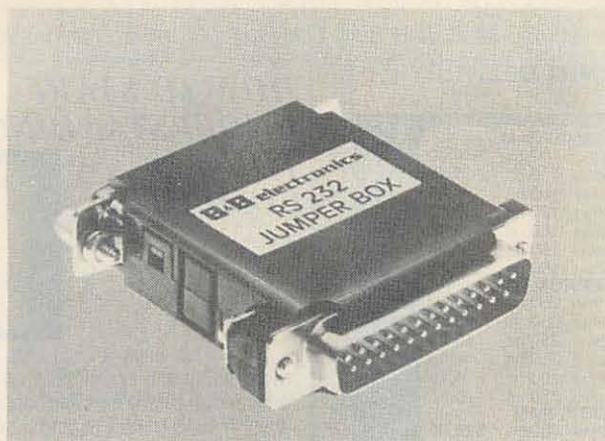


FIG. 10—This "D" connector shell is handy for wiring up RS-232 interface adapters. See the text for more information.

glowed. Repeat the process on the printer, recording everything. You can assign some pin numbers. The output of the computer should connect to the input of the printer, and vice versa. Don't forget to connect pins 7 on both devices together.

You'll have to decide on the "Busy" protocol you'll be using, i.e., hardware or software. If you have no reason for either, choose software, as it's more universal, so the same port could be used with both a MODEM and a printer, without having to re-configure. If you go the hardware route you'll have to find the busy signal. With a printer, that's not too difficult. Connect your probe to pins 7 and 20. Note the color of the LED, then press the printer's "ON-LINE" switch. If the LED changes color, there's a chance you've found the Busy line. If the LED didn't change colors, try pins 4, 5, 6, 8, 11 or 19. Failing that, try all other pins one by one. Failing that, you'll have to contact your supplier or the manufacturer—and good luck with the latter!

You won't be able to use the LED probe to find the Busy input to your computer because, since it is an input, it won't make the LED glow. If you don't have it in your system documents, try pin 20. But first make sure that pin is not an output. If it is an output, try working with the other pins mentioned. Do so systematically, writing down your findings at each step. As frustration increases, we are increasingly likely to forget what we've already done. Remember, outputs go to inputs, and vice versa.

After all wires are connected, (at least tentatively), you'll need to make sure your computer knows that you have hooked the printer up. We can't stress the importance of this step; if we had a dollar for every interfacing problem we helped debug that eventually turned out to be a case of the computer's simply not knowing the device had been attached—we'd be writing this from a villa on the Riviera! Anyway, for CP/M systems you'll use the STAT command or a custom utility supplied by the manufacturer of your machine. MS-DOS machines will use the MODE command, or, again, a custom utility.

Let's do this a step at a time. First let's see if we can get just one character to the printer. Use the quickest method you have for getting a character to the device.

CP/M and MS-DOS owners can type a CNTL-P followed by some data (assuming the printer is set up as the normal LST: or PRN device.) The printer should print everything you type at the keyboard until your next CNTL-P. Apple, Commodore and Sinclair owners will find using BASIC the simplest way of experimenting. Just use LPRINT statements like the following (don't forget the semicolon):

10 LPRINT "A";

Let's assume you sent one character to the printer. If it printed correctly, try sending another. If that works, try sending a number of characters, and follow them with a CRLF. In BASIC use:

10 LPRINT "EVERY GOOD BOY DOES FINE"

If nothing at all is printed, but the computer doesn't lock up (or, in MS-DOS, you don't get the "Abort, Retry, Ignore?" message), chances are the computer is sending data out some other port, and doesn't realize you're hooked up. If you end up having to re-boot (Reset) your machine a few times while experimenting, don't forget to initialize the port each time.

If garbage is printed, you probably have a Baud rate or protocol problem. Unless you have a specific reason not to, set both your computer and your printer up to operate with one start bit, eight data bits, one stop bit, and no parity. And if you are using a software protocol, make sure both devices use the same protocol. You can't run the computer with ETX/ACK and the printer with X-ON/X-OFF!

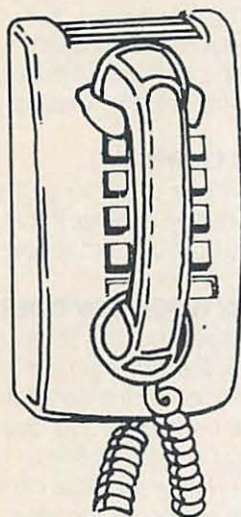
If your printer locks up after the first (sometimes second) character, you most likely have a Busy line problem. After sending each character the computer looks for some acknowledgement that it is safe to continue, and it may just loop forever waiting for a "high" at its busy input. To solve that problem, find a signal that appears to remain high and try connecting it to the pins you know are inputs (to the computer port), one by one, again writing down what happens at each

Table 1
Debugging a Microcomputer Interface

1. Get all relevant documents for both machines
2. Decide on hardware or software "Busy" protocol
3. Assign and configure computer port (1 start and 1 stop bit, 8 data bits, no parity, unless specifically need other.)
4. Configure peripheral port exactly the same as printer port.
5. Make wiring diagram.
6. Assign pin numbers:
 - A. Use documents, if available, otherwise
 - B. Use LED tester to determine all outputs on both machines, especially TD, DTR, RTS.
7. Wire up most likely configuration using breakout box.
8. Get one character to transmit without locking up computer. If incorrect data prints, baud rate probably incorrect. If nothing prints, possible wiring error or port incorrectly configured. Use spare video terminal, if available, to verify data is being transmitted.
9. Get a second character to transmit. If computer locks up, probably busy line is not properly connected. Don't forget to re-initialize port.
 - A. Busy line should toggle each time "ON-LINE" switch is pressed.
 - B. Problem may be with MODEM lines (4, 5, 6, 8). Try tying high, singly and in combination, if necessary.
10. Print a couple of lines. If that works, print a several-page document. If data is lost, "Busy" line not working.

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step. After making each connection, check if the computer has "unlocked," that is, whether you can type something at the keyboard.

If tying single lines high doesn't solve the problem, you may have to tie several lines high. MODEM control pins 4, 5, 6 and 8 are particularly likely candidates for that treatment. Try connecting them to pin 20.

After you've gotten the "Busy" line working, try printing a document several pages long. It may be that, even though the computer didn't "lock up," the "Busy" line wasn't doing its job. If, after successfully printing a part of your document, other parts seem to be lost, the printer is missing data from the computer because the computer is not reading the "Busy" line. The information presented in this section has been summarized in Table 1. Cut it out and paste it up near your workbench so you can refer to it when you need it.

If you need more help, human resources are the best. Try local computer clubs, or computer stores. Many

electronic bulletin boards have special interest groups for people with various equipment. You might try leaving a "HELP!" message on a bulletin board with appropriate special interest groups.

For more technical information on the RS-232 standard, a good place to start is a book called *RS-232 Made Easy* by Martin D. Seyer (Prentice Hall: 1984). Seyer gives a good discussion of the MODEM control lines, summarizes the EIA standards, and lists, in several appendices, output connectors and interconnections for several hundred popular computers and printers. No MODEMs are included in the charts, however.

A good source for RS-232 adapter cables and test equipment is B & B Electronics, P.O. Box 1008H, Ottawa, IL 61350. They manufacture a very useful, yet quite inexpensive (\$1.75) "D" connector shell (Model 232CS). As shown in Fig. 10, one or two 25-pin "D" connectors may be mounted in the 232CS, and that allows very neat do-it-yourself adapters to be made. ◀▶